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ABSTRACT

A three-phase Delphi technique was used to help members of the National Association for Research in Science Teaching (NARST) identify areas and priorities for research. In the first phase, members were asked to nominate three areas of needed science education research. A total of 729 areas were nominated by 248 respondents and were categorized into 35 generic research statements. Secondly, respondents assigned a priority rating to each statements. Data from these responses were analyzed to establish central tendency and dispersion characteristics for each item. The statements were then rerated by each participant after being given the group response data. Analysis of the responses from the third phase revealed a higher degree of consensus on nearly all items. In terms of NARST member responses, the top five statements were: (1) Application of learning and cognitive development theories to classroom instruction; (2) Analysis of classroom learning behaviors that facilitate science learning; (3) Identify what elements are essential in translating both research and development activities into classroom practice; (4) Analysis of strategies for acquisition, retention, and transfer of problem solving in students; and (5) Identification and validation of strategies to assist preservice and inservice teachers in acquiring specific teaching skills. (Author)

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PRIORITIES FOR RESEARCH IN SCIENCE EDUCATION

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PRIORITIES FOR RESEARCH IN SCIENCE EDUCATION

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In April of 1976 the Department of Science Education at the University of Georgia began a study to determine priorities for research in science education. The study was done at the request of the Research Committee of the National Association for Research in Science Teaching (NARST)[1]. The committee had been asked by the Executive Board of NARST to coordinate the study.

The initial impetus for a study of research priorities came from a request by officials at the National Institute of Education for a statement from NARST that outlined the research tasks the members of the organization believed to be most important. However, the need for establishing priorities for research goes beyond the interests of a federal agency in establishing research priorities. College and university science education groups and individual science education researchers periodically need to examine the type of research activities on which they propose to expend their personal or institutional resources.

The purpose of this report is twofold. First, the procedures followed by the University of Georgia research group in obtaining information from NARST members about their priorities for research are presented. The second purpose is to describe the results of the survey by presenting the categories of research proposed by members of the organization and their rankings of them.

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[1]Members of the committee included Stanley Helgeson, Chair (Ohio State University), Edward Smith (Michigan State University), William Torop (West Chester State College), and Paul Koutnik (Illinois Institute of Technology).

The Delphi technique was selected as a means of establishing research priorities among the NARST membership. Delphi is a method for obtaining group judgements on factual matters, which lack precise information, or on values, for which information is a matter of opinion (Sweigert and Schabacker, 1974). The value of Delphi in this study rested in its potential to establish a set of science education research priorities from a large group of respondents with diverse opinions and values.

The iterative structure of the Delphi technique is the mechanism which distinguishes it from other group decision-making processes (Skutch and Hall). Participants offer their perceptions and respond in the light of previous actions and feedback from a summary of the judgements of all respondents in previous rounds. According to Sweigert and Schabacker (1974), the process of making successive judgements with feedback reduces the variance in the responses of the respondents. This convergence appears to be greatest on the first round after feedback than on any other subsequent rounds (Cyphert and Gant, 1970).

Procedure:

The format of the study was shaped by the decision to utilize the Delphi technique. Obtaining input from as many NARST members as possible, tabulating that data, and returning this information to assist responders in further defining their research priorities was the study objective. Meeting this objective indicated use of Delphi in a three-phased study procedure.

Before priorities could be established on a series of research topics, the topics themselves needed to be identified. This was accomplished in

Phase I of the study. In May, 1976 each member on the NARST mailing list (N=780) received a description of the study and a form requesting nomination of three "needed areas of research in science education." Responses from 248 persons listed 729 areas of research. Twenty-two forms of the 780 were returned as undeliverable as addressed.

Phase I ended with a categorization of the 729 research area nominations. When the majority of the Phase I nominations were received, generic statements were generated by listing the priorities contained in the individual nominations. When duplicate content occurred, nominations were grouped into categories where appropriate. When a nomination did not fit an established generic category, a new category was written. The result of this analysis was a set of thirty-five statements. A second review of the nominations was then made by another person in which each nomination was categorized by using the thirty-five statements of priority. There was more than a .90 agreement between these two raters. The results of this process are in Table I. The contrast in frequency in nomination is illustrated in the column "Phase I - Initial Nominations." The range of nominations for each statement was from 1 to 59.

In Phase II, the list of 35 generic statements of needed research in science education was also mailed to the 780 persons on the NARST mailing list. Directions for this form requested each person to rate each generic statement on a 1 to 10 priority scale, with one indicating high priority and ten low priority. The 35 statements were listed in a random order. A total of 327 responses (41% of NARST mailing) were returned. The data were analyzed to ascertain the mode, mean, standard deviation, and percentage of respondents selecting each item. A summary of the mean and standard deviation of these data are displayed in Table I.

Since a small number of Phase II responses were received which did not list the name of the responder, further inquiry was made to match response with responder. The number of unusuable responses in Phase II was six.

In Phase III of the study, each respondent from Phase II (N=327) was mailed a copy of the statistics from Phase II, as well as their personal response sheet. Directions asked that respondents " ... reconsider your response in relation to those of your colleagues ..." and again indicate a priority of from one to ten. Of the 327 who received information in this phase, 209 persons responded 64%. Data from Phase III were analyzed in a similar way to Phase II and a summary of that data is contained in Table I.

DISCUSSION

Establishing priorities within groups of professional researchers is not a simple task. The problem is particularly difficult when the alternatives are numerous as in this study. The Delphi technique was suitable for securing maximum input in establishing priorities. As noted, initial suggestions came from 248 persons, nearly 33% of the NARST membership.

The frequency of nominations is itself one way to establish priorities. The number of suggestions for each research area can be seen as an indication of the importance attached to these areas. Numbers of votes may be deceptive, however, for there may be widespread but weak interest. Or individuals may not consider the many possible areas of research. The second round of a Delphi study compensates for both these deficiencies. All nominations are shared with all group members who rate each according to degree of importance. It is interesting to note in Table I that the generic research areas with relatively few nominations (e.g. #7, 8) were

given high ratings in subsequent rounds. On the other hand, two areas with many nominations (e.g. #11, 14) were given lower ratings.

Another important strength of the Delphi techniques is its potential for achieving consensus at Phase III. The results of surveying the NARST membership indicate that there was more agreement on the ratings after Phase III than after Phase II. The variance among the responses decreased from Phase II to Phase III for thirty-two of the thirty-five research areas. In only one case (#30) did the variance increase after Phase II.

A second interesting finding during Phase III was the change in mean ratings. The rating of the 24 highest-rated research areas increased during Phase III. At the same time, the six lowest-rated areas were rated lower at Phase III than at Phase II. In addition to increasing agreement on each item, there appeared to be increasing polarization between high- and low-rated areas.

Examining the 35 research areas creates an almost irresistible urge to identify "the most pressing need" or "highest priority" and to find commonalities among high- or low-rated areas. However, the wisdom of doing either is debatable. The research areas may have been stated in generic terms so broad that it would be difficult to determine what triggered a response in a responder. Also, the measurement error in each case is large enough to prohibit distinctions between priorities of adjacent items ($S_{\bar{x}}$ = .15). Of course, there is a significant difference between items separated by several ranks in the list.

Recognizing the uncertainty in the task, a few observations are desirable. Perhaps the strongest supported generalization about the priorities is that the <u>practicality and ease of application</u> of the research

product diminishes with the lower rated priorities. The more highly rated research areas were characterized by applying theory to teaching or to learning or by identifying strategies that facilitate teaching or learning. Implicit in both these areas is the potential for changing practice -- in classroom teaching or in teacher education. Developing or testing theory, developing materials, and pursuing interests in specific populations all were ranked low in the list.

This preference for practical or applied research is distinctive and may represent a change in position over the last dozen years. An assessment of change is not possible, however, because priorities of the sixties can only be inferred from the writing of a few (Tyler, 1967; Cooley, 1961; Novak, 1963). This study can provide baseline data in 1986 for determining if priorities have changed in the last decade. Even though this study does not identify <u>the</u> top priority for research in science education, it does indicate which areas are <u>a</u> high priority of the science education research community -- knowledge which should help researchers determine how to devote their energies and resources in the future.

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TABLE I
Science Education Ranking of Research Categories

Statement Order Based on Final Ranking	Phase III $\bar{X}$	Phase III SD	Phase II $\bar{X}$	Phase II SD	Phase I (Initial Number of Nomination)
1. Application of learning and cognitive development theories to classroom instruction.	2.5	1.6	3.0	2.0	21
2. Analysis of classroom teaching behaviors that facilitate science learning.	2.5	1.9	3.0	2.1	42
3. Identify what elements are essential in translating both research and development activities into classroom practice.	2.7	1.7	3.1	2.1	31
4. Analysis of strategies for acquisition, retention and transfer of problem solving (critical thinking or inquiry skills) in students.	2.7	1.9	3.1	2.1	26
5. Identification and validation of strategies to assist preservice and inservice teachers in acquiring specific teaching skills.	2.9	2.1	3.3	2.2	46
6. Relationship between motivation, attitudes and performance (in both students and teachers).	3.0	2.0	3.5	3.0	48
7. Identification and development of teacher education strategies (inservice and preservice) designed to facilitate professional growth and concerns of teachers, including commitment to continued growth.	3.0	2.1	3.5	2.3	12

TABLE I (continued)

Statement Order Based on Final Ranking	Phase III $\bar{X}$	Phase III SD	Phase II $\bar{X}$	Phase II SD	Phase I (Initial Number of Nomination)
8. Identification and validation of teaching behaviors and instructional strategies that facilitate student self-concept, knowledge and attitudes.	3.1	2.2	3.5	2.3	6
9. Identification and validation of specific learner characteristics which relate to successful achievement in science.	3.2	2.0	3.6	2.2	21
10. Definition and validation of goals of science instruction, e.g., balance between process and process objectives, philosophical and theoretical basis of science instruction, articulation of goals for students at all levels, K-16.	3.2	2.3	3.7	2.4	21
11. Identification of factors which influence formation of attitudes in students, e.g., value clarification in environmental education, attitudes toward science and technology.	3.3	2.0	3.5	2.1	59
12. Needs assessment of current practices as a basis of decision making for the development of science curriculum and teacher education materials -- at junior high or middle school level	3.4	2.1	3.7	2.4	10
13. Needs assessment of current practices as a basis of decision making for the development of science curriculum and teacher education materials -- at elementary level	3.5	2.1	4.0	2.6	20

TABLE I (continued)

Statement Order Based on Final Ranking	Phase III $\bar{X}$	Phase III SD	Phase II $\bar{X}$	Phase II SD	Phase I (Initial Number of Nomination)
14. Application of learning and cognitive development theories to concept formation.	3.5	2.1	3.9	2.4	63
15. Design of longitudinal studies to identify what kinds of gains are important to a variety of student populations.	3.5	2.2	3.9	2.4	27
16. Development and evaluation of instructional materials which draw from and integrate more fully sciences, social sciences, and mathematics.	3.6	2.1	3.9	2.4	10
17. Needs assessment of current practices as a basis of decision making for the development of science curriculum and teacher education materials -- at senior high level	3.7	2.2	4.0	2.4	14
18. Analysis of relationship between discipline (subject matter) structure and cognitive structure of the learner.	3.7	2.2	4.0	2.5	15
19. Identification and validation of alternative evaluation schemes for teachers and pupils.	3.8	2.0	4.0	2.1	17
20. Needs assessment of current practices as a basis of decision making for the development of science curriculum and teacher education materials -- at college level	3.8	2.4	4.0	2.6	6

TABLE I (continued)

Statement Order Based on Final Ranking	Phase III $\bar{X}$	Phase III SD	Phase II $\bar{X}$	Phase II SD	Phase I (Initial Number of Nomination)
21. **Analysis of decisions related to curriculum implementation -- e.g., choosing, using and evaluating curricula including analysis of what science teachers see as key decisions.**	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
22. Identification and design of instructional materials in subject content areas for teachers essential to support successful science instruction.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
23. Analysis of effectiveness of instructional system with specific goals and target populations -- e.g., CBTE, PSI, Open Education, Mastery Learning, etc.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
24. Identification of characteristics of a professionally competent and committed teacher.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
25. Identification and validation of specific teacher characteristics and knowledge which relate to successful teaching styles using ethnographic approaches.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
26. Development and evaluation of instructional materials which are integrated with non-science areas such as reading, language arts, fine arts, etc.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27. Development of alternative instructional strategies for use with learners with special problems--e.g., EMR, bi-lingual, culturally deprived, non-reader, minorities, etc.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE I (continued)

Statement Order Based on Final Ranking	Phase III $\bar{X}$	Phase III SD	Phase II $\bar{X}$	Phase II SD	Phase I (Initial Number of Nomination)
28. Construction of a theory of science instruction.	4.8	3.1	4.3	3.2	8
29. Assessment or impact of non-school experiences on students' knowledge in science, mathematics, social studies, etc.	4.[illegible]	2.4	4.9	2.4	8
30. Analysis of residue effects of the NSF supported curriculum developments.	5.3	2.8	5.2	2.3	19
31. Influence of political and technological pressures on science instruction, science teacher needs manpower -- e.g., public attitudes and science enrollments.	5.[illegible]	2.4	5.4	2.5	33
32. Identification of management skills needed for maintaining a viable learning classroom environment--e.g., discipline grouping, bookkeeping skills.	[illegible]	[illegible]	5.4	2.8	3
33. Description of current perceptions of middle school, high school and college graduates about the nature of life, matter and energy, about usefulness and desirability of alternative teaching modes and strategies.	[illegible]	[illegible]	[illegible]	3.1	11
34. Analysis of factors which characterize the reluctant science teacher.	6.[illegible]	2.8	6.[illegible]	2.9	5
35. Comparison of goals of science teaching today with those of 10-20 years ago as viewed by a variety of society's segments--e.g., parents, teachers, students, and teacher educators.	6.[illegible]	2.3	7.3	2.6	1